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POTATO DISEASES AND THEIR TREATMENT.

BY

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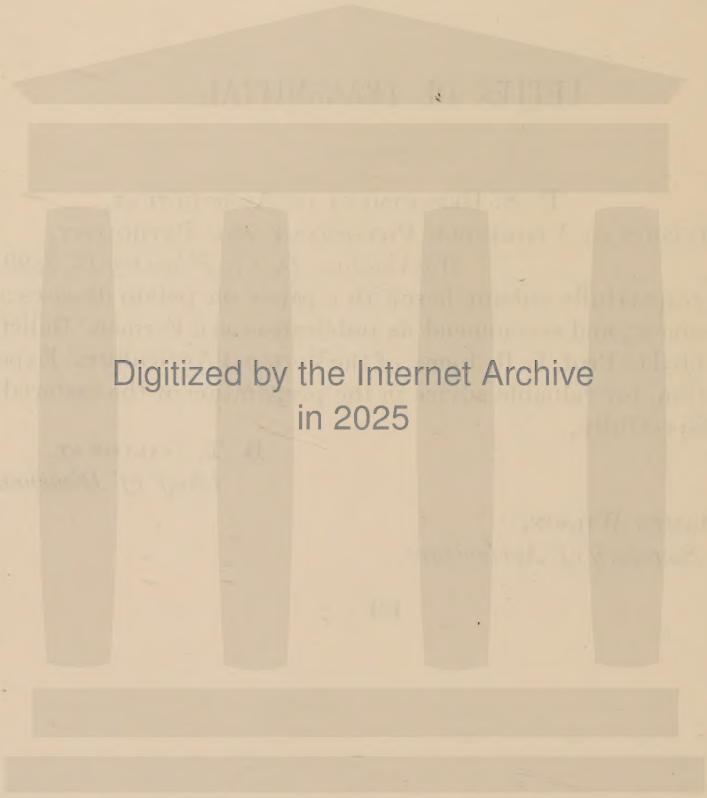
U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF VEGETABLE PHYSIOLOGY AND PATHOLOGY,
Washington, D. C., February 15, 1899.

SIR: I respectfully submit herewith a paper on potato diseases and their treatment, and recommend its publication as a Farmers' Bulletin. I am indebted to Prof. L. R. Jones, of the Vermont Agricultural Experiment Station, for valuable advice in the preparation of the material.

Respectfully,

B. T. GALLOWAY,
Chief of Division.

Hon. JAMES WILSON,
Secretary of Agriculture.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POTATO DISEASES AND THEIR TREATMENT.

INTRODUCTION.

A number of diseases affect the Irish potato in this country, and the losses they occasion are often a serious drain on the farmer's income. The object of this bulletin is to briefly describe the most important diseases and to outline methods of treatment which experience has shown to be successful in holding them in check.

POTATO LEAF BLIGHT, OR EARLY BLIGHT.

(*Alternaria solani* (E. & M.) Sorauer.)

This disease is widespread and destructive. It is confined to the leaves and green stems, and appears about the time the tubers begin to form, but may be noticed earlier if the growth of the plants has been checked in any way. The first indication of its presence is the appearance on the leaves of grayish brown spots, which soon become hard and brittle. The disease progresses rather slowly, the spots gradually becoming larger, especially along the edges of the leaflets. At the end of ten days to two weeks half of the leaf surface may be brown, withered, and brittle (fig. 1), while the rest is of a yellowish green color. Three weeks or a month may elapse before all the leaves succumb. The stems in the meantime remain green, but they too finally perish through lack of nourishment. The tubers stop growing almost as soon as the leaves are attacked, and as a result the crop is practically worthless.

TREATMENT.

Early blight may be held in check by the application of the fungicide Bordeaux mixture. This is prepared and applied as follows: Pour into a 50-gallon barrel 25 gallons of clean water; then weigh out 6 pounds of crushed bluestone, or copper sulphate, and after tying it in a piece of coarse sacking suspend the package just beneath the surface of the water by means of a string tied to a stick laid across the top of the barrel. In another suitable vessel, such as a tub or half barrel, slack 4 pounds of fresh lime. Slack the lime carefully by pouring on small quantities of water at a time, the object being to obtain a smooth, creamy liquid, free from grit. When the lime is slacked add

sufficient water to make 25 gallons. As soon as the bluestone is dissolved, which will require an hour or more, pour the lime milk and bluestone solutions together, using a separate barrel for the purpose and stirring constantly to effect a thorough mixing. It sometimes happens that sufficient lime is not added, and as a result the foliage may be injured. To be certain that the mixture is safe, hold a steel knife blade in it for two or three minutes, and if the polished surface of the blade shows a copper-colored tinge add more lime, but if it stays bright the mixture is safe to use. Application of the mixture should begin when the plants are 4 to 6 inches high, and should be repeated at intervals of twelve to fourteen days until five or six treatments have been made. By adding 8 ounces of Paris green to each barrel of the Bordeaux mixture a combined fungicide and insecticide is obtained, and this will prevent the attacks of the Colorado potato beetle, the flea beetle, and other insects. Before adding the Paris green it should be mixed with a small quantity of water, and when a thin paste is obtained this should be thoroughly stirred into the barrel of Bordeaux solution.

FIG. 1.—Characteristic appearance of leaf affected with early blight.

The success attending the application of the Bordeaux mixture depends in large measure upon the thoroughness with which it is applied. To reach all parts of the plants above ground with a fine spray requires a good force pump and a suitable nozzle. The knapsack sprayer, now on sale in nearly every section of the country, will be found one of the most useful machines for spraying fields of 3 acres or less. For larger plantations more powerful machines should be used. A cheap and serviceable apparatus, well suited for this work, may be made by mounting a good, strong force pump on a barrel, and then placing the barrel and mounted pump in a light wagon. The entire outfit, including barrel, pump,

hose, nozzles, operator, and boy to drive, may be drawn by one horse As the wagon is drawn slowly between the rows the man in the wagon may operate the pump and at the same time keep the mixture stirred, while two others on the ground hold the nozzles and direct the spray over the plants. The nozzle found to be best suited to the work is the Vermorel. This is now offered for sale by pump manufacturers and dealers in seeds and agricultural implements in various parts of the country. Where there are only a few plants to treat, simple devices for the application of the fungicide, such as watering cans, the syringes used by florists, etc., may be used.

POTATO BLIGHT, LATE BLIGHT, OR ROT.

(*Phytophthora infestans* (Mont.) de By.)

This disease attacks the leves, stems, and tubers. Generally the first noticeable effect upon the leaves is the sudden appearance of brownish or blackish areas, which soon become soft and foul smelling. So sudden is the appearance of the disease in some cases that fields which one day look green and healthy may within the next day or two become blackened, as though swept by fire. The rapid spread of the disease, which is caused by a parasitic fungus, is dependent in large measure upon certain conditions of moisture and heat. A daily mean or normal temperature of from 72° to 74° F. for any considerable time, accompanied by moist weather, furnishes the best conditions for the spread of the parasite. On the other hand, if the daily mean or normal temperature exceeds 77° for a few days, the development of the disease is checked. This fact explains why the fungus seldom occurs to any serious extent in sections where the mean or normal daily temperature exceeds 77° for any length of time, and probably why it appears later than the disease discussed under the former heading. The tubers affected with the disease show depressed, dark-colored areas on the surface (fig. 2), while within are blotches and streaks of a brownish or blackish color. Other diseases may produce similar effects, so that in this case the changes are not so characteristic as those shown by the leaves. For many years it was believed that most of the injury to the potato was due to this disease, but recent investigations have shown that view to be erroneous.

FIG. 2.—Late blight, due to *Phytophthora infestans:* *1*, Blight of the foliage; *2*, discoloration and rotting of the tuber.

TREATMENT.

The same treatment as recommended for early blight should be followed here, and will be found to prevent the blighting of the tops and rotting of the tubers. In regions where late blight is known to occur, care should be taken to begin the application of the Bordeaux mixture before the attacks of the fungus. In all this work it must be constantly kept in mind that the main object is prevention rather than cure. Benefit will undoubtedly result if only clean, healthy potatoes are used as seed. Decayed and discolored tubers should be fed to the hogs, as it is poor policy to plant them.

FIG. 3.—Brown rot of the potato: Wilting of stem and leaves and browning of tubers.

BROWN ROT.

(*Bacillus solanacearum Smith.*)[1]

This disease occurs in many parts of the South, and, in addition to attacking the potato, is found to seriously injure eggplants and tomatoes. In the case of the potato, the leaves, stems, and tubers are affected. The disease usually manifests itself by a sudden wilting of the foliage and soon the whole plant may become affected, the leaves and stems shriveling and then turning brown or black (fig. 3). The disease reaches the tubers through the stems, producing a brown or black discoloration of the tissues and ultimately a complete breaking down or rotting of all the parts. Brown rot is caused by a bacillus, a minute organism, which multiplies in the tissues and through its action produces the effects mentioned. Various insects, such as Colorado beetles, flea beetles, and blister beetles, serve as carriers of the disease. These insects may feed on a diseased plant, and in their visits to adjoining healthy ones infect the tissues through bites and possibly in other ways.

TREATMENT.

Throughout the South, namely, in South Carolina, Mississippi, Alabama, and adjacent States where this disease is known to occur, a thorough system of spraying, such as recommended for early blight,

[1] Smith, Erwin F., Bul. No. 12, 1896, Division of Vegetable Physiology and Pathology.

should be followed. In addition, all diseased vines should be removed and destroyed as soon as possible, and the tubers should be dug and either used at once or stored in a cool, dry place. In planting it would be well to avoid land which has just been used for tomatoes or egg-plants, and finally seed tubers from localities where the disease is absent should be used if practicable.

POTATO SCAB.

(*Oospora scabies* Thaxter.)

Scab is one of the most widespread diseases affecting the potato. Injuries of various kinds may produce a roughened surface, but it is safe to say that most of what is known as scab is due to the attacks of a minute parasitic fungus, first studied and described by Dr. Roland Thaxter, of Harvard University. The effects of the disease on the tuber

FIG. 4.—Potato affected with scab.

are so characteristic that figure 4 will, we believe, enable any one to indentify it.

TREATMENT.

Potato scab may be successfully controlled by treating the seed previous to planting. Two fungicides are used for the purpose, namely, corrosive sublimate solution and formalin solution. To prepare the first, dissolve 2½ ounces of corrosive sublimate or bichloride of mercury, in about 2 gallons of hot water and after ten or twelve hours dilute with clear water so that the whole quantity makes 15 gallons. Corrosive sublimate is a poison and must therefore not be placed where it can fall into the hands of children or irresponsible persons. To prepare the formalin solution, mix 8 fluid ounces of commercial formalin (otherwise known as 40 per cent formic aldehyde) with 15 gallons of water.

To treat the potatoes with the corrosive sublimate solution, immerse them for an hour and a half in the liquid and then spread out to dry.

Finally cut and plant in the usual manner. A large barrel is a convenient receptacle for the solution. The potatoes may be placed in a coarse sack and suspended in the liquid, care being taken to wash the tubers before dipping, provided they are very dirty. All treated tubers should be planted in order to avoid danger from the poison upon them.

It has been shown that the formalin is fully as effective against scab as the corrosive sublimate solution, and as it is far less dangerous it will probably come into more general use. In treating seed with this preparation the whole potato should be soaked for two hours in the solution already described. After soaking, the potatoes may be dried, cut, and planted in the usual way, care being taken not to allow them to become contaminated by coming in contact with bags, boxes, or bins where scabby potatoes have been kept. In practice it is found that 15 gallons of either of the foregoing solutions will be sufficient to treat 20 to 25 bushels of potatoes, taking ordinary precautions of course not to waste too much of the fluid as each lot of tubers is dipped.

TIP BURN, LEAF BURN, OR SCALD.

This disease of the leaves occurs in many parts of the country and is often confused with early blight. The tips and edges of the leaves turn brown and these discolored areas soon become hard and brittle.

The burning or scalding may occur at any time and as a rule is the result of unfavorable conditions surrounding the plant. Long-continued cloudy and damp weather followed by several hot and bright days is very apt to result in the burning of the foliage. This is especially the case on soils carrying a comparatively small percentage of moisture. When the weather is cloudy and damp the tissues of the potato become gorged with water and this has a tendency to weaken them. If the sun appears bright and hot when the leaves are in this condition, there is a rapid evaporation of the moisture stored up in their cells. The evaporation may be faster than the supply furnished by the roots, and if this continues for any length of time the weaker and more tender parts first collapse, then die, and finally turn brown and dry up. Tip burn may also occur as the result of protracted dry weather.

TREATMENT.

Little of a specific nature can be said on the treatment of this trouble. Numerous factors are involved in the matter, so that only general statements are possible. Every effort should be made to keep the plants in good growing condition, for if they become checked through lack of proper food or cultivation or both they are more apt to burn. It is a fact that where the Bordeaux mixture is used for other diseases burn is less apt to occur, and this furnishes another instance of the remarkable properties of the fungicide. Briefly, there

fore, the plants should be kept as vigorous as possible by good cultivation, plenty of available food, and the application of Bordeaux mixture, as recommended for early blight.

ARSENICAL POISONING OF POTATO LEAVES.

In many sections where Paris green in water is applied to potatoes injuries are produced which can not be distinguished from early blight by any ordinary examination. It frequently happens, therefore, that farmers are led to believe that their potatoes are affected with early blight and other diseases when the trouble has been brought on by themselves through the improper use of Paris green. Injuries resulting from the use of this substance are very apt to occur where flea beetles have eaten the foilage. The arsenic attacks the tissues at such points, and as a result more or less circular brown spots are produced, having for their centers the holes eaten out by the flee beetles. By combining the Paris green with Bordeaux mixture, as already described, these injuries may be wholly avoided.

CONCLUDING REMARKS.

The cost of the work of spraying as described here will depend to a considerable extent upon the kind of machinery used and the price paid for labor. With suitable apparatus, and labor at $1.50 per day, potatoes may be sprayed six times for about $6 per acre. This estimate is based upon experiments extending over several years, and includes the cost of chemicals as well as labor. The cost of treating scab is mainly in the labor involved in dipping and drying the seed, and seldom exceeds 15 cents per acre. Much attention has been given to the effects of Bordeaux mixture on the growth and yield of potatoes aside from its value in keeping parasitic foes in check. It has been shown conclusively that it pays to apply this preparation if for no other purpose than to induce a more vigorous growth. Three or four applications of the mixture have in many cases increased the yield of potatoes 50 per cent, so that no matter where the crop is grown or whether diseases are present or not the writer feels warranted in recommending the application of the mixture, on the ground that its use will yield a handsome return.

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O

$H(OH)$ $NaCl$

HCl

HNO_3 Na_2SO_4

$H_2(SO_4)$

H_2CO_3 Na_2CO_3 $BaCl_2$

$NaOH$ $BaSO_4$

$Ba(NO_3)_2$

$HC_2H_3O_2$ $Ba(C_4H_4O_6)$

$NaC_2H_3O_2$ $Na_2C_4H_4O_6$

$Ba(C_2H_3O_2)_2$ $Ba(C_2H_3O_2)_2$